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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

May 11, 1994

William Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, DC 20054

Re: **Ex Parte Presentation**
PR Docket No. 93-61
Rules for Automatic Vehicle Monitoring

Dear Mr. Caton:

Pinpoint Communications, Inc. ("Pinpoint") has been an active participant in PR Docket No. 93-61 in which the Commission is considering the adoption of final rules for automatic vehicle monitoring ("AVM"). Pinpoint, a developer of a high-capacity, wide-area AVM system, the ARRAY™ network, supports the adoption of rules that will establish an environment for the competitive provision of wide-area AVM services in a manner that accommodates continuing use of the band by others, including consumers of unlicensed Part 15 spread spectrum devices.

At an ex parte meeting of Pinpoint representatives with members of the Office of Engineering and Technology on Monday, May 9, 1994, questions were raised concerning the amount of bandwidth needed by terrestrial AVM systems. The issue was discussed whether, in comparison with the spectrum requirements of wideband wide-area AVM, it would be possible to conserve spectrum using the Global Positioning System ("GPS") in combination with one of the many voice-based, narrowband signalling technologies carrying the in-vehicle location solution to remote location (where, for example, an automated dispatch function was being performed.)

Without addressing the extremely important matters of whether the "availability" or accuracy of GPS in the urban environment are suitable for the markets that the ARRAY™ system was designed to serve, such as IVHS applications, Pinpoint provides herein an estimate of the total bandwidth required to support GPS, and an appraisal of application performance of remote vehicular radiolocation based on GPS.

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The bandwidth required by a terrestrial AVM system, such as the ARRAY™ network, is determined primarily by the following considerations: ameliorating the distorting effects of urban multipath propagation and limitations on radiolocation speed and accuracy in the 900 MHz mobile communication environment, and the perceived market need for quick response to requests for vehicle location (since the value of vehicle location data "ages" rapidly in most mobile resource management applications). If the radiolocation network is to perform valuable services, it must provide adequate ranging resolution and accuracy. This requirement sets a fairly "hard" bound for a terrestrial system's occupied bandwidth. A ranging resolution of approximately 100 feet requires that multipath echoes be resolved to within a similar level. To achieve this requires a bandwidth of between 15 and 20 MHz ((1.5 to 2)/(100 nanoseconds)), depending mainly on implementation trade-offs.

As a starting point for evaluating the bandwidth needs of GPS, it is assumed that comparisons are being made with an ARRAY™-like system with a capability of providing at least one thousand position fixes per second within a region of between five hundred and one thousand square miles. It is assumed further that the ARRAY™ system provides these fixes on vehicles polled in random order. In the execution of a vehicular GPS position fix, it is assumed that a dispatch center polls the vehicle, and that, upon receipt of the poll, the vehicle immediately transmits only the coordinate data.

Under this scenario, the most critical operational aspect affecting the throughput of the narrowband channel network supporting GPS will be the polling channel's access control. In present day narrowband voice/data systems (cellular, SMR, ESMR, MIRS, and RAM/Ericsson), access to the data channel is achieved via a separate control channel common for all data channels. Minimum channel arbitration times are currently between 250 and 500 milliseconds. This time must be added to the time needed to synchronize the receiver's data modem (varying over a range of 20 milliseconds to 20 seconds) and the time to actually transmit the data. At the current 4,000 to 10,000 bps user data rates, data transmission times will usually be less than 100 milliseconds. These three time estimates make a (minimum) figure of about 1/2 second per position fix reasonable. Five hundred simultaneously active data channels would therefore be needed to support 1000 fixes per second under the above scenario. At 25 kHz per channel, this would require more than 12.5 MHz, excluding control channels, to support GPS.

As a practical matter, pre-existing narrowband system designs could not achieve this level of performance without a major redesign of their access control mechanisms. As a general matter, these narrowband systems were developed for either simplex or duplex voice operation, where the minimum duration of a "transaction" was about two minutes for a duplex (cellular) call, and about 2 seconds for a simplex call. The needs of the control channel in these systems were balanced against the maximum call setup rate based on the minimum expected call durations. This resulted in a *maximum* call setup rate in the order of only a few tens of calls per second for an entire coverage area. When this inherent system limitation is applied to the polling aspect of the above scenario (*i.e.*, set up calls to very large numbers of vehicles, with very much shorter call times) the narrowband system runs into the control channel setup rate limit, which typically limits the polling rate to between 20 and 30 setups (*i.e.*, position fixes) per second.

Conceivably, a new system could be designed and implemented to fix this access control channel problem, for example, by expanding the control channel capacity. However, at 20 calls per second per control channel, the functional equivalent of about 50 additional "control" channels would be needed to expand the capacity to handle the needed call setup rate in the above scenario. Thus, 1.25 MHz *in addition to* the 12.5 MHz noted earlier, or *a total of 13.75 MHz*, is required to support GPS.

In the above scenario, a multi-channel system with the functional capacity and complexity approaching that of the entire current cellular network is presumably supporting the GPS system. Such a network has a typical metropolitan infrastructure cost of hundreds of millions of dollars. This type of scheme would not be viable for a radiolocation-supporting function alone.

In conclusion, as the above discussion demonstrates, use of GPS would not significantly reduce the amount of spectrum required for high capacity vehicle location when compared to that needed for wide-area AVM systems like the ARRAY™ network. A summary of this letter's evaluation (as well as a comparison of infrastructure and mobile costs are presented on the attachment).

An original and one copy of this letter and its attachment are being filed with the Secretary of the FCC in accordance with Section 1.1206(a)(1) of the Commission's Rules.

Respectfully submitted,

Louis H. M. Jandrell
Vice President - Design and
Development

/bap
Attachment
cc: F. Ronald Netro
Edward R. Jacobs
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ATTACHMENT

BANDWIDTH REQUIREMENTS FOR HIGH CAPACITY VEHICLE LOCATION

TERRESTRIAL AVM vs. GPS

- Assumed number of vehicle locations per area per second: 1000
- Number of 25 kHz wide radio channels to report locations achieved through GPS: 500
    - Transmission time, including set-up, per vehicle location: 500 ms
- Total amount of bandwidth required for land mobile channels, including additional access control channel capacity (1.25 MHz), to support GPS: 13.75 MHz
- Amount of bandwidth required for Pinpoint ARRAY™ system: 12-16 MHz
- Pinpoint ARRAY™ system handles, within the same signal, both vehicle location and vehicle status information
- Pinpoint ARRAY™ system is designed for vehicle location in urban areas that cannot obtain complete GPS coverage
    - GPS is a useful technology on open highways
    - With addition of expensive dead-reckoning capabilities and a differential correction signal, GPS can meet certain fleet management needs in urban areas. This requires: GPS receiver, dead reckoning system (motion/distance/orientation sensors/computer), differential receiver, two-way radio to communicate position, and two or three antennas
- Cost of Pinpoint ARRAY™ base station: $10,000 to $15,000
    - Number of base stations in mature Washington-Baltimore ARRAY™ system: 100 to 130
- Cost of cellular base stations: $500,000 to $1,500,000
    - Number of cellular base stations in mature Washington-Baltimore cellular system: 100 to 150
- Cost of ARRAY™ mobile unit: $300
- Cost of differential GPS/dead reckoning/cellular equipped mobile: approximately $3,000